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## NONRULE POLICY DOCUMENT

**Title:** Drilling Procedures and Monitoring Well Construction Guidelines

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**Brief Description of Subject Matter:** These procedures for borings and monitoring well installations for the Office of Land Quality remediation programs have been compiled from State Statutes and Rules IC 25-39, 312 IAC 12, 312 IAC 13, and 329 IAC 9; combined with some clarifications and specifics pertinent to the remediation programs. Program specific requirements may also be applicable, and the respective IDEM program should be consulted before drilling.

**Citations Affected:** IC 25-39, 312 IAC 12, 312 IAC 13 and 329 IAC 9

This nonrule policy document is intended solely as guidance and does not have the effect of law or represent formal Indiana Department of Environmental Management (IDEM) decisions or final actions. This nonrule policy document shall be used in conjunction with applicable laws. It does not replace applicable laws, and if it conflicts with these laws, the laws shall control. This nonrule policy document may be put into effect by IDEM thirty days after presentation to the appropriate board and after it is made available to public inspection and comment, pursuant to IC 13-14-1-11.5. If the nonrule policy is presented to more than one board, it will be effective thirty days after presentation to the last. IDEM will submit the policy to the Indiana Register for publication. Revisions to the policy will follow the same procedure of presentation to the board and publication.

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### **Drilling Procedures and Monitoring Well Construction Guidelines**

These procedures for borings and monitoring well installations for the Office of Land Quality remediation programs have been compiled from State Statutes and Rules IC 25-39, 312 IAC 12, 312 IAC 13, and 329 IAC 9; combined with some clarifications and specifics pertinent to the remediation programs. Program specific requirements may also be applicable, and the respective IDEM program should be consulted before drilling.

## **Part 1. Installation of Borings and Monitoring Wells**

### **(I) DRILLING METHODS**

- (A) Drilling methods used for borings and to install monitoring wells must meet, at a minimum, the following criteria:
  - (1) The method of drilling a borehole for a monitoring well or for exploration must be selected to ensure the following:
    - (a) Subsurface materials are not adversely affected.
    - (b) Ground water or aquifers are not contaminated or cross-contaminated.
    - (c) Continuous and representative formation samples can be collected.
    - (d) Equipment sensitivity allows adequate determination of an appropriate screen location.

- (e) The diameter of the borehole is at least two inches larger than the diameter of the well casing and screen, to allow adequate placement of the filter pack and annular sealants.
- (f) Drill fluids other than water are to be avoided. However, if they are unavoidable, those used must be demonstrated to be inert, and a statement provided regarding the potential impact of drill fluids on the physical and chemical characteristics of the subsurface and ground water.
- (2) All equipment that may encounter contaminated formation materials must be decontaminated prior to drilling each new borehole. Sampling equipment must be decontaminated between sampling intervals. Decontamination fluids must be captured, containerized, and properly disposed of, as described in Sections XI and XII.
- (B) Common drilling methods:
  - (1) Hand Augers: This method may be used for borings less than fifteen (15) feet deep.
  - (2) Solid-Flight Augers: This method can not be used since the auger is solid, and proper soil sampling cannot be conducted. Soil sampling or logging from auger cuttings is not acceptable.
  - (3) Hollow Stem Augers: Similar to Solid-Flight Augers, however, the hollow center portion allows for the collection of undisturbed sediments using a split-spoon sampling device. The hollow center also allows for the installation of well materials without the possibility of borehole collapse. Wells cannot be installed in bedrock, but can be installed in most unconsolidated materials.
  - (4) Air Rotary: Used mostly for drilling bedrock wells. Special filters must be installed on the compressors to prevent fumes from the engine from entering the well. Due to possible borehole collapse, this method should not be used in unconsolidated materials. Given the large volume of air introduced to the hole, it is possible that biodegradation, oxygenation, or vaporization could occur as a result of the drilling. Sampling of wells installed using this method must be postponed until this effect has dissipated.
  - (5) Air Rotary with Casing Driver: With the addition of a casing driver, air rotary methods can be used in unconsolidated materials.
  - (6) Direct Push: Being economical and fast, this method is extremely well suited for shallow soil borings, to obtain grab samples and cores for field exploration and characterization. However, various problems have been encountered with their use for monitoring well installations, and, because monitoring wells are used to protect the safety of the citizens and environment of Indiana, conservative and proven methods must be utilized. At this time, direct-push wells, without complete sediment removal, are not approved for use as monitoring wells. If a minimum four-inch diameter core barrel is used to make the hole, and a two-inch inside diameter well is properly installed per this guidance, then it would be acceptable. Using a four-inch drive point to compact material to the side of the hole is NOT acceptable, even if some, but not all, of the material was previously removed by a sampler. Exemptions for unusual circumstances, such as rig access in a building, may be made on a site-specific basis, only if written approval is obtained from the IDEM site manager or geologist before installation.
  - (7) Rotasonic: This method is particularly well suited for well installation without cross-contamination in thick unconsolidated deposits and heaving sands. It also provides a higher percent core recovery than hollow stem augers.
  - (8) Cable Tool Drilling
  - (9) Dual-wall Reverse Circulation
  - (10) Fluid Rotary (also known as Mud or Water Rotary)

The last three methods presented are seldom used to drill monitoring wells, but may be used in some applications. The person responsible for installing the monitoring well should consult with IDEM if one of these methods is being considered. For a more in-depth description of most of the above methods, consult the USEPA Document "Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells" EPA/600/4-89/034.

## **(II) BOREHOLES**

- (A) Boreholes, used to sample soils and for one-time-only ground water screening (grab) samples, (and the boring properly abandoned afterwards), may be any diameter as long as quality samples can be obtained. However, small diameter cores may not yield sufficient material for field descriptions and laboratory analyses.
- (B) Any wells used to sample ground water more than once shall be drilled and equipped with a casing having a minimum of two (2) inches inside diameter installed in an open borehole having a diameter of at least two (2) inches greater than the outside diameter of the casing. Boreholes for monitoring wells must be drilled by methods which will remove the formation material. Methods which compact or push the formation materials to the side of the boring may not be used.

## **(III) MATERIAL SAMPLING AND ANALYSES**

- (A) Continuous downhole samples of the unconsolidated and consolidated materials must be collected in all borings, unless otherwise approved by the IDEM geologist or site manager. Monitoring wells installed within five feet of a previously made boring do not have to be sampled if adequate samples and a log from the nearby boring were obtained. For well clusters, continuous samples must be collected from the surface to the base of the deepest well. Samples for description or laboratory analyses must be as undisturbed as possible, auger cuttings are not acceptable.
- (B) If direct push methods are used for sampling in contaminated or suspected contaminated areas, a well casing or double walled tube must be used to prevent cross-contamination or smearing.
- (C) For borings installed to delineate the extent of contamination, all soil intervals should be field screened using appropriate, properly calibrated instrumentation; suitable for detecting the type of contaminant present. Field screening instruments are useful only for qualitative measurements but can not be used to define the extent of contamination, which must be done using laboratory analyses. Samples for laboratory analysis should be taken at least from the interval exhibiting the highest field screening results, or directly above the water table if all readings are low.
- (D) For borings installed to delineate the extent of contamination, sampling must continue until the soil is clean, not just to a pre-determined depth or the water table. Confirmatory laboratory samples should be taken at the base of each boring to define the vertical extent of contamination.
- (E) All procedures regarding sampling and testing must be described to IDEM in writing.

## **(IV) CASING MATERIALS**

- (A) A well shall be equipped with casing having a nominal inside diameter of at least:
  - (1) Three-fourths (3/4) of an inch for a piezometer installed for monitoring ground water levels only.
  - (2) Two (2) inches if the well is installed for the purpose of taking ground water samples to monitor the quality of groundwater.
- (B) Monitoring well casing shall be new first class material, which meets the American Society of Testing and Materials (ASTM) standard ASTM A-53 (1987) or the American Petroleum Institute (API) standards API SPEC 5D or API SPEC 5L. Thermoplastic pipe shall comply with ASTM F-480 (1981). Well casing shall be:
  - (1) Clean and free of rust, grease, oil, or contaminants; and composed of materials that will have minimal impact on the quality of a water sample.
  - (2) Composed of materials which will not be degraded or react with the contaminants of concern.
  - (3) Sealed with commercial O-rings and mechanically fastened or threaded together without the use of glues, oils, or joint compound.
  - (4) Centered in the borehole and free of obstructions, so that monitoring or sampling devices can be lowered into the well.

## **(V) WELL SCREEN AND FILTER PACK**

- (A) A monitoring well screen shall be composed of materials that will not corrode or react with chemicals found in the ground water at the site, and conform to casing material standards in Section IV.
- (B) Screen lengths must be not less than two (2) feet and not greater than ten (10) feet, unless approved by IDEM.
- (C) Screen placement must be based on the type(s) and phase(s) of contamination and type of aquifer.
  - (1) If light non-aqueous phase liquids (LNAPLs), are the contaminants of concern, then the well screen should be placed at the top of the aquifer.
  - (2) If dense non-aqueous phase liquids (DNAPLs) are the contaminants of concern, then nested wells should be installed, extending slightly below the base of the aquifer. If DNAPLs are suspected, great care must be taken not to breach confining layers, which could spread the contamination to a deeper aquifer.
  - (3) In an unconfined aquifer, and if the contaminants of concern are LNAPLs, the well screen must be set straddling the water table, to allow for seasonal water table fluctuations to remain within the screened interval.
  - (4) If the aquifer is confined, the screen should be set to detect the type of contamination present. The presence of all reportedly confined aquifers must be verified by site data, which may include:
    - (a) An obvious and continuous, dry confining layer.
    - (b) Wells with screens set above the supposed confined aquifer that exhibit a definite head difference from the confined aquifer.
    - (c) A separate water bearing zone above the confined aquifer.
- (D) Commercial, factory-slotted, well screens shall be sized to retain at least ninety percent (90%) of the grain size of the introduced filter pack.
- (E) The filter pack shall be properly sized and graded so that silt and clay-sized sediments will not clog the well screen. A filter pack material must consist of inert sand or gravel and shall comply with the following:
  - (1) A uniform grain size must be chosen which is three (3) to five (5) times the average fifty percent (50%) retained size of the formation material, unless this filter pack grain size would impede adequate flow of ground water into the well. Should this happen, a filter pack grain size shall be used that allows ground water flow into the well and prevents as much silt infiltration as possible.
  - (2) Natural, granular material, which will not clog the well screen, may be an acceptable constituent of the filter pack if slump is unavoidable.
  - (3) The filter pack in bedrock is optional. However, if used, the filter pack must be of a nonreactive coarse sand or gravel.
  - (4) The upper one (1) to two (2) feet of the filter pack must be of fine, inert sand to prevent infiltration of seal materials.
  - (5) The filter pack must be emplaced without bridging.
  - (6) The filter pack shall extend at least one (1) foot but not more than two (2) feet above the top of the screen or the uppermost water bearing unit to be monitored.
  - (7) Pre-packed well screens may be used, if the packing material is sized correctly.
  - (8) For shallow monitoring wells less than three (3) feet below the surface, it may not be possible to install a full-length filter pack or seal. If so, the filter pack should extend just above the screened interval, and the well should be grouted to the surface or surface seal.
- (F) Non-standard configurations of the screen and filter pack must be approved by IDEM.

## **(VI) FILTER PACK SEAL**

- (A) A filter pack seal of clean, fine sand, or pelletized or granular bentonite, or bentonite slurry, must be placed in the annulus directly above the filter pack.
- (B) The seal shall be installed so bridging is prevented, and the filter pack seal can extend to no more than two (2) feet above the filter pack.
- (C) A bentonite filter pack seal must be hydrated if installed above the water table.

## **(VII) WELL GROUTING**

- (A) Granular bentonite may be used to grout a monitoring well if:
  - (1) The diameter of the borehole is four (4) inches or more larger than the nominal diameter of the well casing; and
  - (2) The well is not more than twenty-five (25) feet deep.
- (B) The annulus of a monitoring well shall be pressure grouted with neat cement, a cement and bentonite slurry, or a bentonite slurry from the top of the filter pack (for wells installed in unconsolidated materials) or the bottom of the well casing (for a well penetrating bedrock) to the ground surface or to within one (1) foot of the ground surface if a flush mounted protective cover pipe or well box is installed if:
  - (1) The diameter of the borehole is less than four (4) inches or larger than the nominal diameter of the well casing; and
  - (2) The well is not more than one hundred (100) feet deep.

## **(VIII) GROUTING MATERIALS**

- (A) Well cuttings may never be used for grout. Grouting materials shall consist of:
  - (1) neat cement with no more than five percent (5%) by weight of bentonite additive; or
  - (2) bentonite slurry (which can include polymers designed to retard swelling); or
  - (3) pelletized, granular, medium-grade, or coarse-grade crushed bentonite.
- (B) If neat cement or a bentonite slurry is used for grouting, the cement or slurry shall be pumped into place from the bottom of the annular space upward in a continuous operation with a grout pipe, using the positive displacement method.
- (C) Grouting material shall be introduced in a manner to prevent bridging of the annulus between the outside of the well casing and the borehole.
- (D) A borehole annulus shall be grouted upon the earlier of the following:
  - (1) Within twenty-four (24) hours after the installation of the well casing.
  - (2) Before drilling equipment is removed from the vicinity of the borehole.

## **(IX) FINISHED WELL CASING**

Except in areas where the well may be susceptible to damage, the finished well casing shall extend at least two (2) feet above the ground level and, if located in a flood plain, must be at least two (2) feet above the elevation of the regulatory flood (as defined by 310 IAC 6) or be equipped with a watertight cap. The monitoring well shall be located to protect against surface water ponding; and earthen materials, neat cement, or concrete shall be placed around the well casing to drain surface water away from the well. A vented, locked cap is required on all monitoring wells.

If the monitoring well is located in an area where the casing may be susceptible to damage, the well must be equipped with a protective outer metal casing having a diameter large enough to allow easy access to the well. The protective cover shall be firmly anchored in the ground and be equipped with a locking cap. Additional protective devices, for example; brightly colored posts around the well, are required where construction equipment or vehicular traffic could damage the well. Alternatively, the top of the well casing can be finished at an elevation below the ground surface and shall be located in a flush mounted protective cover designed for the purpose. The flush mounted protective cover pipe shall include each of the following:

- (A) A watertight one (1) piece of continuous welded metal casing at least one (1) foot long and having a nominal diameter at least four (4) inches greater than the nominal diameter of the monitoring well. The casing shall be flanged for greater stability if installed in a location likely to be subject to vehicular traffic.
- (B) A concrete ground surface seal, if an impervious surface is not present. The ground surface seal shall be at least six (6) inches thick and extend no more than three (3) feet below the ground surface.
- (C) A sealed lid which is not more than one-half (1/2) inch higher than the elevation of the ground surface. The sealed lid shall be of a quality to withstand vehicular traffic if installed in a location likely to be subject to vehicular traffic. The lid shall be clearly marked with the words "MONITORING WELL" and also display the words "DO NOT FILL".

## **(X) WELL DEVELOPMENT**

A monitoring well shall be developed following installation and at least twenty-four hours before water samples are collected. This development shall be accomplished to produce water which is free as practicable from sediment, drill cuttings, and drilling fluids. If a well is installed to monitor ground water quality, the well shall be adequately developed to produce a representative sample of the ambient groundwater. Well development needs to be confirmed by taking measurements of turbidity, until readings stabilize.

## **(XI) DRILLING FLUIDS, CUTTINGS, AND DEVELOPMENT WATER**

Contaminated, or potentially contaminated, solids and liquids produced in the drilling of borings and development and sampling of a monitoring well shall be collected and contained to prevent contamination of the area and to protect persons who might otherwise come in contact with these materials. They can not be disposed on-site without IDEM permission, used for grout, or returned to the borehole or well. Materials known or suspected to be contaminated must be sampled and properly disposed, according to applicable regulations.

## **(XII) DECONTAMINATION**

Drilling and development equipment that comes in contact with contaminated water or contaminated geologic materials shall be cleaned with high pressure hot water or steam, using inorganic soap or other suitable solvents, and rinsed thoroughly. Contaminated fluids or wash waters shall be collected, contained, and properly disposed, to prevent contamination of the area or a hazard to individuals who may come in contact with these materials.

## **(XIII) USE OF LICENSED WATER WELL DRILLER**

All monitoring wells shall be installed by an Indiana licensed water well driller as defined in IC 25-39. The name and license number of the driller must be included on all boring and well logs.

## **(XIV) REPORTING REQUIREMENTS**

- (A) All information must be typed. Handwritten logs are not acceptable.
- (B) Diagrammatical borehole drilling logs must be of similar scale and include the following information:
  - (1) The borehole identification.
  - (2) The date of drilling or installation.
  - (3) The method of drilling.
  - (4) The name and certification of the driller and geologist.
  - (5) The borehole diameter.
  - (6) The method of sampling consolidated material and unconsolidated material.
  - (7) The type of any drill fluids, fluid additives, or lubricants other than water, that have been used.
  - (8) Penetration measurements, such as hammer blow counts, penetrometer measurements, or other acceptable penetration measurements.
  - (9) The sample recovery measured to the nearest one-tenth (.10) foot.
  - (10) Consolidated material and unconsolidated material field descriptions, including the following information:
    - (a) Lithology and sedimentology.
    - (b) Mineralogy.
    - (c) Degree of cementation or HCL reaction.
    - (d) Degree of moisture.
    - (e) Evidence of contamination, such as field screening, odors or staining,
    - (f) Color as referenced from soil color charts such as the Munsell soil charts.

- (g) Grain size and textural classification of unconsolidated samples as referenced from the United States Department of Agriculture textural classification charts. Consolidated samples must be described using accepted geological classification systems and nomenclature. A clear description of the classification system used must be included with the logs.
- (h) Any other physical characteristics of the consolidated material and unconsolidated material such as fracturing, solution features, or pedologic characteristics.
- (11) Distance to, and depth of, water bearing zones, measured to the nearest one-hundredth (0.01) foot.
- (12) Location information sufficient to permit the boring or well to be found on site. Acceptable methods include a scaled map, UTM coordinates, state plane coordinates, legal descriptions, etc.
- (13) Location of samples.
- (C) Diagrammatical construction and design logs of all pertinent ground water monitoring wells must also include the following information:
  - (1) The composition of well and protective casing materials.
  - (2) The type of joints and couplings between well casing segments.
  - (3) The elevations of the top of the well casing and the ground surface, surveyed to the nearest one-hundredth (0.01) foot, and referenced to mean sea level.
  - (4) The diameter of well casing and borehole.
  - (5) The elevation of the bottom of the borehole and the depth of the borehole.
  - (6) The screen slot size and type.
  - (7) The depth and elevation range of the screened interval.
  - (8) The screen length, measured to the nearest foot.
  - (9) Methods of installation of the annular fill.
  - (10) The elevation range and the depth of the filter pack
  - (11) The grain size and composition of all filter pack materials and the fifty- percent (50%) retained size of the formation material used to determine filter pack materials.
  - (12) The elevation and depth range of the bentonite seal above the filter pack.
  - (13) The composition of annular fill.
  - (14) The elevation range, depth range, and thickness of annular fill
  - (15) The composition and design of the surface seal.
  - (16) The design and composition of materials used for the protection of the well casing.

## **Part 2. Abandonment of Borings and Monitoring Wells**

### **(I) TIMEFRAME**

- (A) Boreholes must be permanently abandoned before the drill rig or equipment is moved from the area.
- (B) Wells can either be temporarily or permanently abandoned. Any monitoring well that has not been used or maintained for a period of one (1) year must be permanently abandoned in accordance with Part 2. III, Permanent Abandonment. A request to defer abandonment, containing the reason(s) and the time period the well is expected to remain in use, must be made in writing to the IDEM project manager.

### **(II) TEMPORARY ABANDONMENT**

A well which has not been used for more than three (3) months without being permanently abandoned must be sealed at or above the ground surface by a welded threaded or mechanically attached water tight, locking cap. The well shall be maintained so that the well does not become a source or pathway for groundwater contamination.

### **(III) PERMANENT ABANDONMENT**

Boreholes and wells shall be plugged with an impervious grouting material to prevent the migration of materials or fluids in the well and the loss of pressure in a confined aquifer. The well screen and casing shall be completely filled with impervious grouting material. The surface expression of the well shall be cut off one (1) foot below the surface.

### **(IV) PLUGGING MATERIAL (GROUT)**

The plugging material must consist of one (1) or a combination of the following:

- (A) Neat cement with not more than five percent (5%) by weight of bentonite additive.
- (B) Bentonite slurry (which can include polymers designed to retard swelling).
- (C) Pelletized, medium-grade, or coarse-grade crushed bentonite.
- (D) Other materials approved by the IDEM.

### **(V) PLUGGING METHODS**

The following methods apply:

- (A) Cement and bentonite slurries shall be pumped into place in a continuous operation with a tremie grout pipe introducing the plugging material at the bottom of the boring or well and moving the pipe progressively upward as the hole is filled.
- (B) Plugging materials other than neat cement or bentonite slurry shall be installed in a manner to prevent bridging of the well or borehole. The well or borehole shall be measured periodically throughout the plugging process to ensure that bridging does not occur.
- (C) Upon abandonment of any borehole or monitoring well, a written notice of permanent abandonment, referencing the abandonment date, boring or well identification, and location, shall be provided to the IDEM site manager within thirty (30) days after plugging is completed.
- (D) Well plugging must be performed by an Indiana certified well driller.

## **Part 3. Definitions**

**“Abandon”** means to terminate use of a boring or monitoring well and to restore the site in a manner that will protect ground water resources from contamination.

**“Bentonite”** means clay material composed predominantly of sodium montmorillonite, which meets American Petroleum Institute specifications standard 13-A (1985).

**“Bentonite slurry”** means a mixture, made according to manufacturer specifications, of water and commercial grouting or plugging bentonite, which contains high concentrations of solids. The term does not include sodium bentonite products which contain low solid concentration or which are designed for drilling fluid purposes.

**“Bridge”** means a barrier created by any object or material which prevents the introduction of grouting materials or sand pack in the borehole or well.

**“Coarse grade crushed bentonite”** means natural bentonite crushed to an average size range of three-eighths (3/8) to three-fourths (3/4) inches.

**“Confined aquifer”** means an aquifer which is bounded above and below by impermeable layers, and which contains sufficient hydrostatic head to cause ground water to rise above the upper boundary of the aquifer.

**“Contamination”** means the degradation of natural water quality as a result of human activities.



**“Direct-Push”** well means a type of drill rig which uses direct pressure to push a tool instead of augers or a cable tool. These are not acceptable for installing monitoring wells.

**“Grab Sample”** means a discrete one-time only screening sample taken from a borehole.

**“Grout”** means fluid material (composition defined in Section VIII) poured or injected into a well to form an impermeable seal.

**“Grout or tremie pipe”** means a length of hose or pipe positioned in the annular space of a well, between the well casing and the borehole, used for the introduction of grouting materials.

**“Medium grade crushed bentonite”** means natural bentonite crushed to an average size range of one-fourth (1/4) to three-eighths (3/8) inch.

**“Monitoring well”** means a two (2)-inch minimum inside diameter well constructed to these guidelines, installed to obtain physical, chemical, or biological information or to monitor the quality of ground water. A monitoring well may not be used for remediation applications and continue in use for monitoring.

**“Neat cement”** means Portland cement (ASTM C-150) and water, mixed five (5) to six (6) gallons of water per ninety-four (94) pound bag of cement.

**“Piezometer”** means a type of monitoring well used only to measure groundwater levels. Piezometers can not be used for monitoring groundwater quality.

**“Temporary monitoring well”** is a slang term usually referring to a non-standard “well” which does not meet these construction guidelines, and is used for periodic ground water sampling. Such “temporary monitoring wells” are not acceptable without specific advance approval from the IDEM site manager. One-time screening or grab samples may be taken from borings or direct push holes, but periodic samples must come from monitoring wells properly installed per these guidelines.

**“Thermoplastic pipe”** means plastic well pipe made of A.B.S. (acrylonirile butadiene styrene), P.V.C. (polyvinyl chloride) or S.R. (rubber-modified polystyrene) with standards listed by the ASTM (American Society of Testing Materials).

**“Unconsolidated formation”** means non-cemented geologic materials or deposits such as sand, gravel and clay.